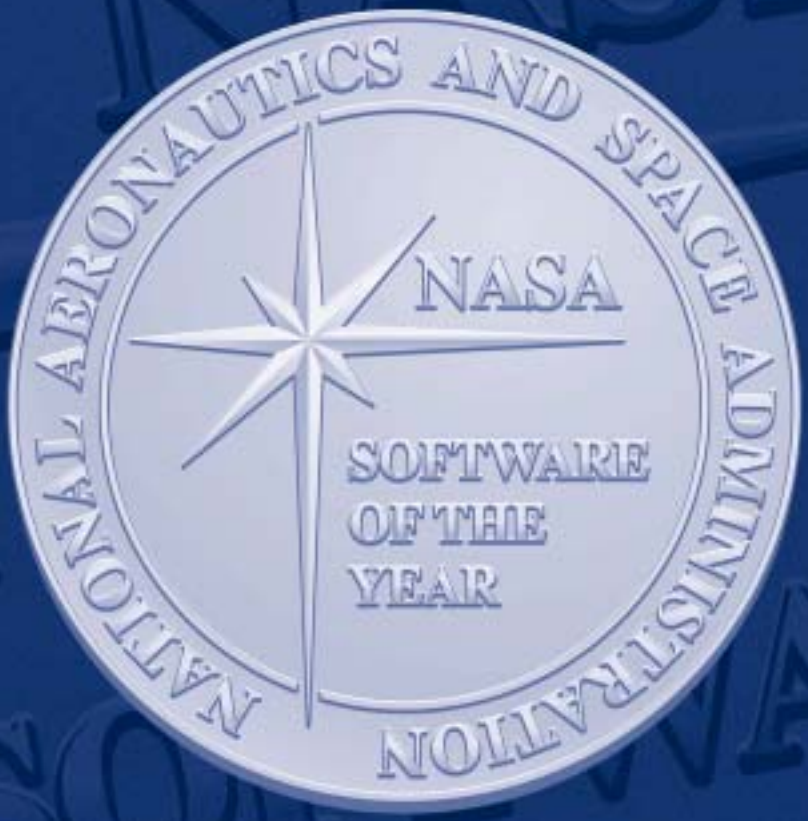
NASA Office of Aerospace Technology
Volume 10, Number 2 March/April 2002

Aerospace Technology

INNOVATION



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About the Cover:
The Software of the Year Award recognizes NASA's best commercialized software. The idea of the starburst is a metaphor for innovation in aerospace, embodied in NASA software. The starburst has always stood for new ideas, a spark with birth and electricity and stars with space.

Online Edition: Go to ***http://www.nctn.hq.nasa.gov*** for current and past issues.

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COMMERCIAL DEVELOPMENT MISSION UPDATE

Date	Flight	Payload	Sponsor/Coordinator
5/02	UF2-05/02	Zeolite Crystal Growth (ZCG) Advanced ASTROCULTURE Microencapsulation Electrostatic Processing System (MEPS)	Center for Advanced Microgravity Materials Processing Wisconsin Center for Space Automation and Robotics Center for Space Power

WELCOME TO INNOVATION

Advancing Software Technology with US Industry

By Jonathan Root
Program Executive, Commercial Technology Division
NASA Headquarters

AS IN INDUSTRY AND SOCIETY, SOFTWARE technology is emerging everywhere at NASA. Software, described as "the oil of the 21st century" by a noted market analyst, is a driving force in the IT revolution, enabling competitive advantages that fuel the nation's prosperity. Likewise, software is vital to the productivity and success of NASA's cutting-edge programs—pushing the frontiers of science, technology and exploration. Thus, research in dependable, intelligent systems and associated software technology is a prime focus of NASA's technology investments, and the generation of software solutions is embedded throughout the agency's R&D activities. In order to accelerate and extend software-related R&D to fulfill NASA mission needs, contribute to commercial innovation and further realize the potential of NASA software technology, we are renewing our efforts to transfer, develop and commercialize such technology in collaboration with US industry.

This initiative encompasses computer code implemented in both software and hardware with embedded programmable devices, along with underlying concepts, processes, algorithms and know-how. It builds upon the teaming between Ames Research Center and other NASA centers with the commercial and university sectors in information technology R&D, as well as our pioneering heritage in software technology transfer. In the mid-1960s, NASA established a software distribution operation that, for the next several decades, successfully transferred NASA computer programs to industry and academia, such as NASTRAN, which became the broadly used basis for structural finite element analysis.

More recently, in recognition of the rising importance and potential of NASA-sponsored software, the agency implemented new policy and business processes in 1998 to manage software as a strategic technology asset. The prime thrusts are to inventory new software developments funded and/or performed by NASA, assess potential commercial applications and establish intellectual property rights. These key steps are carried out by all NASA centers to enable the transfer and commercialization of software in ways that yield benefits for NASA mission programs, US industry and the nation.

As featured in this issue, the winners of NASA's prestigious Software of the Year Award, along with the other software technologies profiled in the following articles, provide a view into the diversity and potential of software technology developed across NASA. The stiff competition for this award reflects the high value NASA places on technical excellence, novel approaches and collaboration in order to produce and put to work software technology that offers new ways to achieve performance advantages, cost savings and other benefits.

Past winners, such as the Embedded Web Technology (EWT) team at NASA's Glenn Research Center, further illustrate the increasing emphasis on mission applications, partnering and commercialization as interrelated parts of the NASA innovation process. Having earned the 1998 Software of the Year Award for their development of the TEMPEST Web server for real-time embedded systems and the transfer of this novel technology to industry, the team has since focused on applications for space shuttle and International Space Station operations, and worked with a variety of commercial firms to further develop and apply EWT. Their efforts recently gained international media attention with the introduction of a Web-enabled kitchen appliance that employs EWT to remotely operate the device. Thus, NASA, as in other key software technology areas, is fueling, and learning from, commercial innovation in the emerging markets for networked embedded systems as a strategy for advancing the innovative application of this high-potential technology.

Another key aspect of the current initiative, in keeping with the President's Management Agenda, is to address conditions that are unduly encumbering NASA's performance in this area. Accordingly, we are pursuing new ways to stimulate and speed software technology transfer, partnering and commercialization in alignment with NASA's R&D priorities, industry needs and commercial practices. As part of an overall e-commerce strategy, for example, the online NASA Commercial Technology Network (*www.nctn.hq.nasa.gov*) serves as a key, developing resource for learning about NASA software technology, accessing opportunities and tapping into technology transfer, development and commercialization assistance.

We welcome you to join us in congratulating this year's award winners and to explore NASA software technology and partnering with NASA's world-class innovators.

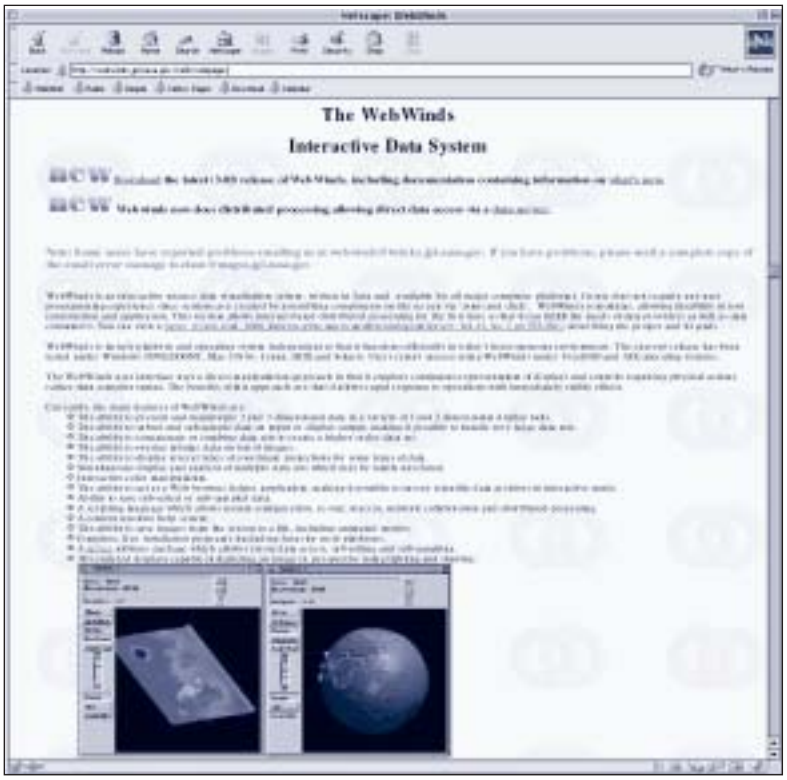
Software Winners Selected for NASA Award

SINCE 1994, NASA HAS CONDUCTED AN ANNUAL, agency-wide competition to recognize and reward excellence in software technology developed for NASA mission activities. Software development teams across the NASA programs and centers compete vigorously for the NASA Software of the Year Award, which is jointly sponsored by the NASA chief engineer and the NASA chief information officer in cooperation with NASA's Inventions and Contributions Board. The prestigious award, which includes a monetary Space Act Award as well as peer recognition and "bragging rights," is based on criteria that emphasize the importance of quality software engineering, innovation, the extent of current and potential use, and significance to NASA mission programs, as well as to science, technology and industry. Qualified contenders for the award are nominated by the NASA centers and must demonstrate that the software is technologically mature or rated as "commercial grade," that it is approved for external release or dedicated to use in a NASA mission activity, and that NASA holds intellectual property in or has access to the software technology. Also, as noted by Dr. Paul Curto, the senior technologist for the Inventions and Contributions Boards, "user testimonials are a vital part of the evaluation process."

The 2001 Software of the Year Award winners are the **Numerical Propulsion System Simulation** (NPSS), which reduces aircraft engine analysis time, and the **Generalized Fluid System Simulation Program** (GFSSP), which improves the study of fluid dynamics in rocket engines and other systems.

The NPSS software allows multifidelity analysis in designing aircraft engines, offering key technological advantages that can improve the US aerospace industry's global competitiveness. The General Electric Aircraft Engines Co. estimates a 55-percent reduction in engine analysis time using this new software.

The development of NPSS was led by Cynthia Gutierrez Naiman of NASA's Glenn Research Center (GRC) of Cleveland, Ohio and included a team of 39 other engineers from Glenn; Arnold Engineering Development, Arnold Air Force Base, Tennessee; Dynacs, Cleveland, Ohio; General Electric Aircraft Engines Co., Cincinnati, Ohio; GESS, Cleveland, Ohio; Honeywell, Tucson, Arizona; Pratt & Whitney, East Hartford, Connecticut; Modern Technologies Corp., Middleburg Heights, Ohio; Rolls Royce Corp., Indianapolis, Indiana; RS Information Systems, Inc., Cleveland, Ohio; and The Boeing Company, Seattle, Washington.



Distributed Direct Object Visualization Environment (DOVE) received an honorable mention in the 2001 Software of the Year competition. The software is a freely available interactive science data visualization system written in Java and available for all major computer platforms.

The purpose of NPSS is to dramatically reduce the time, effort and expense necessary to design and test jet engines. It accomplishes this by generating sophisticated computer simulations of an aerospace object or system, thus permitting an engineer to "test" various design options without having to conduct costly and time-consuming real-life tests. The ultimate goal of NPSS is to create a "numerical test cell" that enables engineers to create complete engine simulations overnight

on cost-effective computing platforms. Using NPSS, engine designers will be able to analyze different parts of the engine simultaneously, perform different types of analysis simultaneously (such as aerodynamic and structural analysis) and perform analyses faster, better and cheaper.

The GFSSP is a general purpose computer program for analyzing fluid-flow rate, pressure and temperature in rocket engines, turbo pumps, fuel tanks and various kinds of fluid-distribution systems. The software is capable of modeling liquid fuel phase changes including compressibility, mixture thermodynamics and the effects of external influences, such as gravity and centrifugal force. GFSSP version 3 introduced a subroutine module that makes it possible to develop specific applications and customize those applications as needed. As a result, GFSSP can be applied across a wide variety of industries and applications where flow predictions in complex flow circuits are necessary. The program includes subroutines for computing "real fluid" thermodynamic and thermophysical properties for 33 fluids, including hydrogen, oxygen, nitrogen, helium, water and kerosene. Nineteen different resistance/source options are provided for modeling momentum sources or sinks in the branches. These options include pipe flow, flow through a restriction, noncircular duct, pipe flow with entrance and/or exit losses, thin sharp orifice, thick orifice, square edge reduction, square edge expansion, rotating annular duct, rotating radial duct, labyrinth seal, parallel plates, common fittings and valves, pump characteristics, pump power, valve with a given loss coefficient, Joule-Thompson device, control valve and a user-specified option.

The flexibility of the GFSSP code and the ability to customize specific applications eliminate the need to develop or employ multiple software tools that often are not fully interoperable. In addition, GFSSP is designed for ease of use, with a point-and-click graphical user interface and the ability to run on a desktop workstation with a PC, Macintosh or Silicon Graphics platform. GFSSP's features combine to yield substantial cost savings through reduced hardware testing and continuous improvement. Used on seven NASA/industry projects, GFSSP has demonstrated its value; one organization's use of GFSSP is estimated to save between $825,000 and $1.5 million.

Alok Kumar Majumdar, of NASA's Marshall Space Flight Center in Huntsville, Alabama, led the development team that included engineers from Marshall; ERC, Inc.; and Sverdrup Technology, also of Huntsville. A US patent has been filed, and potential licensees are in negotiation with NASA for its commercial use. For more information, go to *http://techtran.msfc.nasa.gov/software/gfssp.html*

Receiving honorable mention were the following:

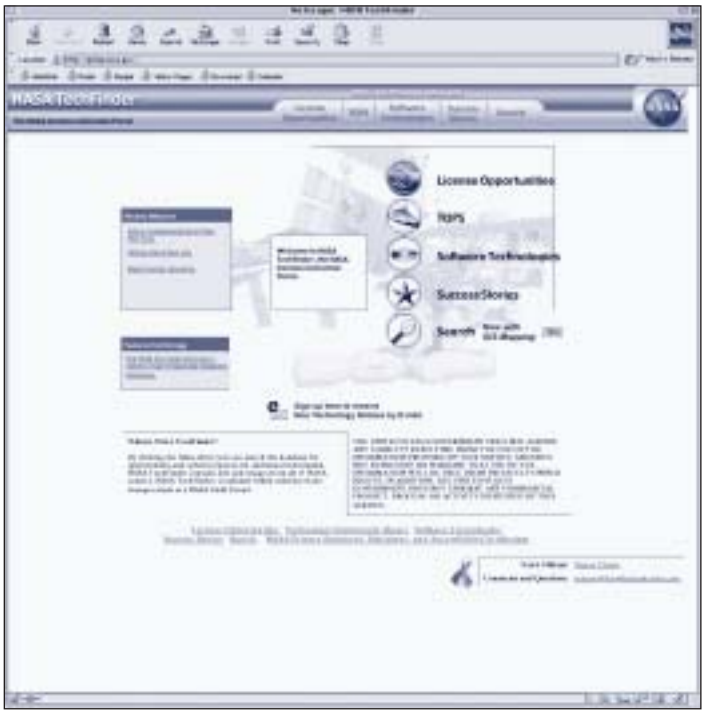
- **Scientist's Expert Assistant**, which enables scientists to develop valid observational proposals for using the Hubble Space Telescope (HST). Historically, the Space Telescope Science Institute (STScI) has provided significant staffing to help general observers develop these "observing proposals." This is a manually intensive, time-consuming and costly effort. In order to meet the operational objectives for the Next Generation Space Telescope (NGST), the time and cost in developing such proposals must be dramatically reduced. Accordingly, SEA was designed to make the user more self-sufficient and thereby minimize staff effort and cost for user support. Furthermore, the SEA was also designed as a reusable system that is easily adaptable to multiple observatories. The SEA approach has been to use a combination of artificial intelligence and user interface techniques to provide a system that minimizes redundant data entry and allows users to approach the process visually. The SEA allows users to express their proposals in terms of the science that they wish to achieve rather than the technical observatory details required to achieve that science; includes a visual tool that allows the user to retrieve an image of the target area and graphically position observations on that area; and is the first proposal preparation tool to provide an interactive visualization capability to observers. Observations obtained by spacecraft are remote and hence separate the observer from the telescope. SEA's visualization strategy brings the "eye back to the sky." SEA was developed at NASA's Goddard Space Flight Center (GSFC).
- **Dynamic Response Computation Software Program (DIRECT)**, which allows the space shuttle and space station programs to conduct multiple quick assessments of structural integrity precipitated by late payload manifest changes without having to execute a full-up NASTRAN model. The space shuttle is used to carry a wide variety of payloads into Earth orbit. To ensure the safety of the astronauts, NASTRAN-based structural assessment is required to determine the integrity of the orbiter and its payloads during

the high-dynamic liftoff and landing events. The manifest changes, weight changes, cargo modifications, math model modifications and loading changes occur often during the construction of the International Space Station. Utilizing the DIRECT software, a traditional full-up shuttle payload assessment process cycle time can be reduced from two months to one week. Use of DIRECT reduces the cost and time of system dynamic analysis without compromising accuracy. In addition, it allows the payload design organization to reduce the complexity of the analysis and significantly reduce the payload design time. DIRECT was developed at NASA's Johnson Space Center (JSC).

- **Distributed Direct Object Visualization Environment (DOVE)**, which is a freely available interactive science data visualization system written in Java and available for all major computer platforms. Its use does not require any user programming experience because sessions are created by assembling components on the screen via a point-and-click process. DOVE is modular, allowing flexibility in tool construction and application. It supports scientific collaboration in many ways; however, its unique feature is that it allows Internet-based distributed processing in a manner transparent to the user. This allows the package to fulfill the needs of data providers, as well as data consumers. DOVE was developed at NASA's Jet Propulsion Laboratory (JPL).
- **NASA TechTracS** is a component of NASA's agency-wide commercial technology information management systems. The system is an integral part of the Commercial Technology Office's daily business process and is the agency's "mission-critical system" for the technology commercialization program and intellectual asset management. NASA TechTracS provides standardized processing of NASA's intellectual assets and technology commercialization program across the agency. It is a key tool for identifying and realizing the vast commercial potential of NASA's technological assets. On an annual basis, it allows NASA to perform the following:
  - Assess the commercial potential of over 10,000 activities;
  - Collect and process approximately 1,300 new technology reports involving more than 3,500 innovators;
  - Administer approximately 1,900 active patents;
  - Execute and administer 1,400 active licenses;
  - Administer over 5,500 active partnerships; and
  - Identify and process approximately 50 success stories.

NASA TechTracS is a distributed network of 4-D relational databases and Web servers located at each NASA center, NASA Headquarters and the National Technology Transfer Center. An integrated agency-wide server is located at NASA's Langley Research Center, as well on as a public Web site called the NASA Tech Finder (*http://technology.nasa.gov/*), a test/training server and a technical support server.

More information about the current and past Software of the Year Award winners can be found at *http://icb.nasa.gov/nasaswy.html*



NASA TechTracS is a component of the agency-wide commercial technology information management systems. It is an integral part of the Commercial Technology Office's daily business process.

Accessing NASA Software Innovations

NASA HAS A RICH TRADITION OF ADVANCING technology to achieve cutting-edge mission objectives. Many of these innovations have been in the form of computer software, developed to support and enable the broad range of functions required by the space agency's missions and operations.

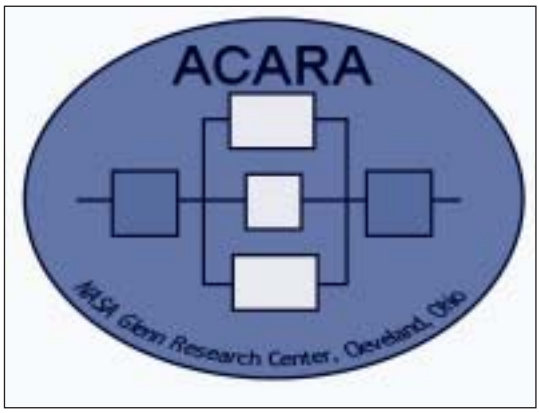
Over the course of its history, NASA has developed advanced software technology at its centers and in conjunction with industry and universities, resulting in thousands of computer programs with a wide array of applications. Since the mid-1960s, NASA has made many of these programs available to US industry and the public, contributing to the development of new technologies and commercial enterprises. For example, the publicly distributed NASTRAN program helped pioneer the creation of the computer-aided engineering industry.

However, in view of the commercial potential of NASA software technology and its rising importance to agency missions, NASA began working last year with a new partner for software distribution and commercialization: Chicago-based Open Channel Software (OCS) and its nonprofit arm, the Open Channel Foundation. The partnership's strong emphasis on e-commerce, open-source approaches and market-driven business models reflects key aspects of NASA's overall initiative to boost software partnering and commercialization.

Vice president of development Douglas Curry, cofounder of the company and a former technology transfer officer at both Purdue University and the University of Chicago, explains that their original vision was "to create a central repository for scientific and technical software and to be able to distribute that software in a manner that emphasizes the positive aspects of what we call 'community involvement.'"

"Our idea was to create a market 'pull' condition rather than attempt to 'push' early-stage, new and/or commercially untried software into a given marketplace, all with an eye toward commercializing those applications that demonstrate market viability," he notes.

The partnership supports NASA's efforts to make its software more accessible to US industry and other enterprises, stimulate and enable collaborative development and foster the adaptation of software to meet both commercial markets and NASA mission objectives. The Open Channel Foundation provides an online means for obtaining NASA software code and applying it to business and industry needs in ways that may yield new commercial opportunities. In turn, OCS focuses on creating new ventures that bring NASA and derived software into the marketplace.



ACARA II software, developed at NASA Glenn Research Center, is now available on the Open Channel Foundation Web site. Logo courtesy of Open Channel Software.

"NASA can enjoy the benefits of increased exposure and visibility for their researchers and programs, as well as the type of market distribution and feedback that helps determine a software's overall value," Curry states.

To date, OCS has launched several activities with NASA software. Its nonprofit arm is hosting much of the original "COSMIC" collection of software on the Web. The collection, dubbed "NASA Classics," contains many old programs that are now enjoying a new lease on life on the Open Channel Foundation's Web site (*http://www.openchannelfoundation.org/*).

Current software from NASA centers is available on the site as well, including the Knowledge Information Center (KIC) from Headquarters, ACARA II and the Java version of Tempest (1998 NASA Software of the Year) from Glenn Research Center and the Shuttle Systems Department Scheduling Tool from Johnson Space Center. This combination of old and new software has resulted in 131,000 unique requests for information about NASA-developed software. With the assistance of a targeted media campaign recently launched by OCS, it is expected that the growing interest in NASA software will fuel collaboration with NASA researchers and the commercialization of software in partnership with NASA.

For more information, contact Doug Curry at Open Channel Software, 773/334-8177, *dcurry@openchannelsoftware.com*. Please mention you read about it in *Innovation*.

NASA Technology Keeps Transit System Safe

A NASA-DEVELOPED, ENVIRONMENTALLY friendly anti-icing fluid that can make railroad and commuter travel safer and more reliable during snowy conditions is now available for commercial applications.

Under license from NASA's Ames Research Center in Moffett Field, California, Midwest Industrial Supply, Inc. of Canton, Ohio has produced several commercial products that prevent the buildup of ice and snow on railways, providing a smooth ride for passengers and helping to eliminate transit system delays and shutdowns resulting from weather conditions.

"This anti-icing fluid, if applied before freezing conditions are encountered, will prevent ice from forming," explains Dr. John Zuk of Ames, one of the developers of the technology. "The fluid also can be applied to an already frozen surface to melt the snow and ice."

The environmentally friendly anti-icing fluid originally was developed by NASA Ames researchers in the 1990s to replace highly toxic and non-biodegradable anti-icing fluids used in the aerospace industry. "Current aircraft anti-icing fluids are not environmentally friendly," Zuk said. "Ames' development, however, is an essentially non-toxic, totally biodegradable and non-corrosive material that improves travel conditions without polluting the environment."

"This remarkable material derived from the space program can significantly enhance products for railroad operations," said Robert Vitale, president of Midwest Industrial Supply, Inc. (MIS). "Now, MIS is ready to offer several products that use NASA's fluid technology to free the railways and transit systems of ice and snow."

THE ENVIRONMENTALLY FRIENDLY ANTI-ICING FLUID ORIGINALLY WAS DEVELOPED BY NASA AMES RESEARCHERS IN THE 1990S TO REPLACE HIGHLY TOXIC AND NON-BIODEGRADABLE ANTI-ICING FLUIDS USED IN THE AEROSPACE INDUSTRY.

The fluid can be pressure sprayed, applied with a brush or poured, depending on the application. When a small amount of the fluid is sprayed on the surface to be protected, a very thin fluid film is formed. If applied before freezing conditions are encountered, the fluid will prevent rain or dew from freezing on the object and will melt fallen snow upon contact.

It also can be applied to melt pre-existing snow and ice, and it prevents refreezing of ice on the object. One of the unique characteristics of the fluid is its strong resistance to the effects of gravity, which prevents removal of the protective coat by rain, snow, wind or gravity-induced runoff.

"We have all been impressed with the results, and now the company is looking to expand the application of NASA Ames' anti-icing fluid to other industries that face similar problems," said Vitale.

The NASA Ames environmentally friendly anti-icing fluid may potentially be used on bridges, streets, runways, ships and boats, automobiles and even around homes (for sidewalks and roofs). "Because the fluid is neither an acid nor a base, it will not corrode steel and reinforced concrete, so roadways and bridges can be safely treated with the fluid," said Zuk. "Similarly, vehicles will avoid the body corrosion typically associated with the use of road salt," he added.

"NASA's commercial technology charter is to transfer new technology developments to industry for commercial use," said Cathy Pochel, technology commercialization manager in Ames' Commercial Technology Office. "This project is not only an outstanding example of this objective, but [it] directly benefits the public as well."

For more information, contact Dr. John Zuk at NASA Ames Research Center, 650/604-6568, *jzuk@mail.arc.nasa.gov.* Please mention you read about it in *Innovation*.

Embedded Web Technology Makes Life Easier

EMBEDDED WEB TECHNOLOGY (EWT), originally developed at NASA's Glenn Research Center to support space shuttle and International Space Station operations, is emerging in commercial form as a result of the center's focused efforts to transfer this innovative, high-potential technology to industry. EWT, which combines Internet, World Wide Web and real-time systems technologies, enables the low-cost, real-time remote control and monitoring of embedded systems via a standard Web browser. Embedded systems contain computers, software, input sensors and output actuators, all of which are dedicated to the control of a specific device.

According to David York, chief engineer of flight software engineering at NASA's Glenn Research Center, as well as the EWT project leader, embedded systems are widely used in consumer and industrial applications. "Embedded systems can be found in cars, video cassette recorders, copy and fax machines, and any number of household, business and industrial objects. And anything that has an embedded system has the potential to include embedded Web technology."

Glenn's EWT team first gained national recognition in 1997 with the introduction of Tempest, the first Web server of its kind for real-time embedded systems and the keystone for EWT applications. From 1997 to 1999, recognizing Tempest's broad potential, Glenn hosted a series of workshops for companies interested in commercializing the server and associated technology. The EWT team earned the NASA Software of the Year Award (1998), the R&D 100 Award (1999) and the Federal Laboratory Consortium Award for Excellence in Technology Transfer (2000) for their pioneering work and technology transfer activities. EWT is now widely known in the software industry, and over 20 commercial vendors are offering Tempest-like embedded Web servers. As part of Glenn's ongoing transfer of EWT, a newly developed Java version of Tempest is currently available from the Open Channel Software Foundation (*http://www.openchannelfoundation.org*).

Since the development of Tempest, York and his team have focused on applications of EWT technology for NASA mission programs and commercial use. For example, the team has demonstrated the use of EWT for highly secure command and control via satellite communications, and has continued working with companies following the workshop series. Potential and emerging EWT applications span health care, factory automation and many other fields of use.

POTENTIAL AND EMERGING EWT APPLICATIONS SPAN HEALTH CARE, FACTORY AUTOMATION AND MANY OTHER FIELDS OF USE.

Most recently, Glenn's EWT has entered the consumer market as an integral part of a prototype home kitchen appliance developed by Tonight's Menu of Brecksville, Ohio. The company, which first learned of EWT in a 1997 workshop at Glenn, employed EWT for their Intelligent Ovens® product. Tonight's Menu debuted the product at the Consumer Electronics Show in Las Vegas, Nevada last January, acknowledging the use of NASA technology and generating substantial media attention. The Web-enabled combination refrigerator/microwave oven can be controlled from outside the home through a Web-ready cell phone or computer. This convenient remote control capability allows the user to direct the appliance to begin cooking the meal, providing a hot, home-cooked meal that can be ready when the user walks in the door. The company plans to ultimately utilize the technology for conventional ovens as well.

Although proud of their accomplishments since 1997, York and the EWT team, eager to fulfill the technology's widespread potential, continue to further develop, demonstrate and apply the technology for NASA use and to seek new opportunities for collaboration with US industry. "We are open to exploring opportunities with those who are interested in advancing this technology," says York.

For more information, contact Gynelle C. Steele, Glenn Research Center, 216/433-8258. Please mention you read about it in *Innovation*.

NASA AND CARNEGIE MELLON SIGN COMPUTING AGREEMENT

NASA's Ames Research Center has signed an agreement to award $23.3 million to Carnegie Mellon University's School of Computer Science to develop a multidisciplinary, multi-institutional High-Dependability Computing Program (HDCP) to improve NASA's ability to create dependable software.

The incremental five-year cooperative agreement is part of a broad strategy for dependable computing that links NASA, Carnegie Mellon, corporate partners and other universities. Carnegie Mellon experts will collaborate with NASA scientists and researchers from universities, including the Massachusetts Institute of Technology, the University of Maryland, the University of Southern California, the University of Washington and the University of Wisconsin, in order to measure and improve the dependability of NASA's systems.

"We are delighted to work with Carnegie Mellon," said Ames Center director Dr. Henry McDonald. "Carnegie Mellon is a leader in computing and robotic technologies. We see this as a cornerstone as we move forward with the development of the NASA Research Park," he added.

"While software dependability has been a theme of computing research for several decades, this program addresses the issue in a new way, looking at the particular challenges of large systems and combining measurement with improvement," said William L. Scherlis, principal research scientist in the Institute for Software Research, International, in Carnegie Mellon's School of Computer Science. Scherlis and James H. Morris, professor and dean of the School of Computer Science, respectively, are principal investigators on the High-Dependability Computing Program.

"This is a unique opportunity to develop an empirically based science for software dependability and could have a major impact on NASA's ability to rely on complex software for advanced mission capability," said Dr. Michael L. Lowry, chief of research in advanced software engineering technology within the Computational Sciences Division at Ames. Previous research collaborations between this division, headed by Dr. Daniel Clancy, and Carnegie Mellon have resulted in tools that formally verify artificial intelligence software that autonomously controls robotics spacecraft. Dependability is a major challenge for all complex software-based systems. Today, there are few effective techniques for measuring dependability and for improving the dependability of large and complex systems. Aspects of dependability include safety-critical reliability, high security, high integrity, continuous operation and human-computer interaction.

Morris explained that the diverse skills needed to accomplish the HDCP's goals do not reside exclusively at any single laboratory. While the principal focus is on strengthening software dependability for NASA, Carnegie Mellon and its partners will develop collaborations with industry and with other major software development efforts, including open-source projects. First-year funding for the HDCP is $2.9 million, which will be divided among Carnegie Mellon's Pittsburgh campus, research efforts on the West Coast and other universities as subcontractors.

The High-Dependability Computing Program is the most recent in a number of important collaborations that Carnegie Mellon has undertaken with NASA. Carnegie Mellon has worked for the past two years to establish a presence in the Silicon Valley. This effort includes formation of the High-Dependability Computing Consortium (HDCC) jointly with NASA and 15 Silicon Valley companies, focused broadly on reducing failures in computing systems critical to the welfare of society. Carnegie Mellon has an agreement with NASA to use facilities at Moffett Field to initiate the program. "Carnegie Mellon has unique capabilities to offer in Silicon Valley, the information technology capital of the world," said Morris. He believes that Carnegie Mellon's presence in the Valley not only makes its offerings more broadly accessible, but can also enhance the educational experience of students at the Pittsburgh campus by giving them opportunities for internships or research with NASA or Silicon Valley companies.

In other work with Ames, Carnegie Mellon researchers have developed high-profile robots such as Dante, which explored the interior of a volcano, and Nomad, which discovered meteorites in Antarctica. In addition, Carnegie Mellon researchers also have worked with Ames researchers on projects such as formal methods for verifying digital circuitry, vision and navigation, machine learning and data mining.

For more information, contact Dr. Michael Lowry at NASA Ames Research Center, 650/604-3369, *lowry@ptolemy.arc.nasa.gov.* Please mention you read about it in *Innovation*.

Mobile Internet Technology Offers New Applications

FOR MORE THAN A DECADE, DATA ROAMING services using private and proprietary wireless technologies have enabled delivery trucks, police, fire and other emergency vehicles to communicate with networks. New advances in Internet Protocol (IP) standards afford the ability to offer mobile IP to NASA programs and millions of users at a much lower cost, with better features, easier scalability and less maintenance required than ever before. To this end, NASA worked with Cisco Systems to conduct field trials of the Cisco implementation of mobile IP, as defined by the Internet Engineering Task Force (IETF) RFC 2002. The effort later tested the Cisco enhancement—Mobile Networks—that is an additional mobile IP feature that eliminates the need for a mobile IP client on each mobile node. The Cisco Mobile Networks solution is available with Cisco IOS® Software Release 12.2(4)T.

BUSINESSES, GOVERNMENT AND CONSUMERS WANT THE MOBILITY OF THE CELLULAR PHONE IN THEIR WIRELESS IP DEVICES, WHETHER ROAMING THE CAMPUS, CONTINENT OR WORLD.

Businesses, government and consumers want the mobility of the cellular phone in their wireless IP devices, whether roaming the campus, continent or world. The mobile IP routing protocol has been a feature of Cisco IOS Software since version 12.0(1)T. It enables hosts to roam seamlessly among IP subnetworks while keeping their original IP addresses and uses tunneling and several specialized discovery protocols.

Mobile IP is also an architecture for network mobility that includes a router called a home agent that tunnels data grams for delivery to a mobile node that can be a laptop, a computer on a satellite, a wireless personal digital assistant, a router or other client device, and maintains the same IP address wherever it goes. The third element is a router on a remote network called a *foreign agent* that provides routing services to a registered mobile node.

"There are a myriad of voice, data and video applications for this technology in both the government and commercial sectors," according to William D. Ivancic, senior research engineer at NASA Glenn Research Center in Cleveland, Ohio where the mobile IP trials took place. "We see using it for space communications in both satellite networks and planetary rovers. In the commercial sector, cars, mobile phones, emergency vehicles, ships, trucks and airplanes could all become mobile nodes."

With the mobile networks implementation in Cisco IOS Software, a router can be a mobile node. Once this mobile router registers with the home agent, it injects its networks into the home agent's routing table and redistributes these routes. In contrast to the existing mobile IP implementation, with a mobile router a second tunnel is established between the home agent and the mobile router in addition to the tunnel between the home agent and foreign agent. The home agent performs two encapsulations of any packet destined for the mobile router and forwards all packets for the mobile network to the foreign agent. The foreign agent then performs one de-encapsulation and passes the packet to the mobile router. The mobile router performs the second de-encapsulation and forwards the packets to the devices on its network.

"As the mobile router moves, it registers with its home agent on its whereabouts by using various foreign agents," says Ivancic. "Mobile router transforms the mobile node into a network rather than a single host. So an entire network can roam."

Such standards-based mobile IP networks that are able to roam at the Layer 3 protocol level and do not require special software on client devices running on mobile LANs will be of interest to just about everybody, according to NASA and Cisco engineers. The resources of other networks (i.e., foreign agents and antennas) can be shared to cut costs. Security is already addressed through IP Security (IPSec) and other protocols.

NASA and Cisco engineers built a wired and wireless mobile testbed at NASA Glenn with Cisco 2600, 3600 and 7500 Series routers to test mobile networks. Four Cisco routers were enabled by mobile IP. Another served as a home agent to handle IP tunneling. Two Cisco routers were foreign agents, one based at NASA Glenn and the other at NASA's Ames Research Center. These had two wireless bridges each that were IEEE 802.11

This van served as the mobile test bed when the Mobile Router LAN was field-tested at NASA Glenn Research Center.

standard. A Cisco 3640 router was the mobile client or node that served as a mobile router. It was installed on a rolling cabinet that was used within the lab and driven around the NASA Glenn grounds in a van. This router was equipped with a voice-over-IP interface card to support telephone conversations and three Ethernet network interface cards (NICs), two of which were configured as roaming interfaces to perform the task of agent discovery through a wired or wireless connection to a foreign agent. The third interface was the connection to the LAN and functioned as both a wireless access point and a wired hub.

Two additional routers were configured as bridges between the mobile router and a foreign agent to provide an interface for a satellite channel emulator. A workstation connected to the home agent acted as a network address translator.

When the van or cart was in the laboratory, the mobile router accessed a wireless Cisco Aironet® antenna, and three other antennas were deployed on buildings throughout the Glenn Research Center. These three antennas were connected to foreign agents that had no delay and simulated delay.

Driven from one end of Glenn to another, the van's mobile router started the trip connected to a delayed, non-preferred path that simulated a satellite link. It then switched to a preferred path, then back to another delayed, non-preferred link. Switching between these paths is initiated by the discovery of new foreign agents with higher priority interfaces or the result of broken connections to the preferred path.

"We successfully validated the general mobile routing algorithms," says Ivancic. "The mobile router performed within roundtrip time delays of three seconds." Applications tested included e-mail transfers, Web browsing, voice-over-IP, FTP file transfers, Secure Shell (SSH) and Telnet.

Mobile IP and mobile networks will play a major role in several current NASA programs, including the Small Aircraft Transportation System (SATS), Weather Information Communication (WINCOMM) and Advanced Aeronautical Transportation Technology (AATT) Free-Flight. These initiatives require continuous network connectivity and mobility between subnetworks.

"Mobile IP has been somewhat held back by the difficulty of putting the code on the clients' software because that is unwieldy," says Dan Shell of Cisco, senior consulting systems engineer for Federal Operations. "Mobile networks will enable mobile IP connections from many types of mobile platforms at a new level of cost-effectiveness, efficiency and ease."

For more information, contact Will Ivancic at NASA Glenn Research Center, 216/433-3494, *William.d.Ivancic@grc.nasa.gov* or Sandy Levine at Advice Unlimited, 301/924-0330, *slevine@adviceunlimited.net.* Please mention you read about it in *Innovation*.

Mars Mission Software Helps Build Facility

VIRTUAL REALITY SOFTWARE, ORIGINALLY developed by NASA engineers to help explore Mars, is now being used by a leading petrochemical company to build and plan operations for a complex industrial facility in "virtual world" simulations.

The Mars Map virtual reality software, developed at NASA Ames Research, Moffett Field, California, guided scientists through the agency's successful 1997 Mars Pathfinder mission. The tool allows mission scientists and operations personnel to command and control remote robotic spacecraft within a virtual environment. Recently, Reality Capture Technologies (RCT), Inc. of San José, California was granted a license for further development of the platform. RCT is deploying this productivity- and life-cycle information-management tool at a new Shell Chemicals process plant currently under construction in Geismar, Louisiana.

"Our product, based on NASA technology, will allow Shell to create and validate startup procedures, in addition to a construction-feasibility review, and commence

training in a virtual environment months before the plant is fully built," said Reality Capture Technologies' chief executive officer Dr. Ted Blackmon.

RCT's software enables engineers to simulate a plant environment in order to review its "constructability," a process of evaluating the design, scheduling, cost and resource planning to assess the possibility of implementing such a design. The software also allows engineers to create operating procedures, training and documentation. Similar to pilot training on flight simulators, this technology enables plant operators to get the training they need in a virtual environment.

"What makes this software even more unique is how simple it is," said Blackmon. "It is almost like a video game where you hold a joystick and walk around making sure that everything is working right. Only in this case, you walk around a not-yet-built Shell plant," he added.

By fusing software systems used during the design stage with those used during construction, the software provides virtual access to a construction site and permits project personnel to manage, assess, control and respond more effectively to changes in the plant's complex construction. Like space explorers who use Mars Map to learn how to get around the red planet, facility operators can use the new tool to learn how to better "pilot" the sophisticated and expensive industrial plant asset.

"Operators can now easily access and understand engineering information that is critical to operations, which makes their job much easier and safer," said Blackmon.

An Ames science team originally developed Mars Map to create a photographic-quality rendering system. Mars Map allowed researchers to better understand the surface of Mars and perform more effective science by providing an accurate visual representation of the planetary terrain.

"The Mars Pathfinder mission was the first test of this new class of photo-realistic, virtual reality systems," said Dr. Michael Sims of Ames, who managed the Mars Map development team. "Mars Map made a big difference in our understanding of Mars during Pathfinder and made us realize that this technology could be an extremely powerful tool for the rendering of the world."

"RCT uniquely addresses the link between various stages of a facility's life cycle, leveraging information generated during the design stage through construction and subsequently into operations and maintenance," said Blackmon. "By leveraging advanced software, originally developed at NASA for the space program, we are able to effectively 'bridge the islands of automation' that exist in the engineering/construction/operations industry today and interconnect traditionally standalone software systems into an end-to-end distributed computing platform."

"This company is a resident of the Ames Technology Commercialization Center, a technology incubator located in San José," said Phil Herlth of the Ames Commercial Technology Office. "Their commercial partnership with a major chemical company is another example of a successful transfer of a space technology that is now benefiting people here on Earth."

For more information, contact Jonathan Rudick of RCT, *jonathan.rudick@reality-capture.com*, 858/945-5532. Please mention you read about it in *Innovation*.

NASA Software Used In Imaging Service

IT HAS BEEN SAID THAT SUCCESS IS NOT A destination, it is a journey. The DATASTAR Image Processing Exploitation (DIPX) program is taking a 20-year-old NASA software program down roads less traveled and, in return, is providing a unique end-user service.

DIPX is an evolution of NASA's award-winning Earth Resources Laboratory Applications Software package, or ELAS, developed at Stennis Space Center. Since the early 1980s, ELAS has been used worldwide for processing satellite and airborne sensor imagery data of the Earth's surface into readable and usable information. While there are several software packages on the market that allow the manipulation of spatial data into usable products, this is usually a laborious task. The DIPX Delivery Service, a subscription service available over the Internet, takes the work out of the equation and provides normalized geo-spatial data in the form of decision products.

DIPX was created by DATASTAR, Inc., a woman-owned computer company in Picayune, Mississippi. End-users interested in spatial data, such as soil content, rainfall levels and other variances of topographical information, but who do not have the time or expertise to eloquently manipulate the data,

will appreciate the convenience of DIPX.

Upon opening an account, users can either request a deliverable product from DATASTAR or access the data sets via their own computers. DATASTAR has provided the system on a secure server to protect its intellectual property and the personal data of its subscribers.

Currently, Web customers open a subscription with DATASTAR for specific data points then log on from their personal computers and manipulate the data to extract several layers of information. DIPX can separate and provide specifics of imagery data, such as data classifications, false color composites, soils, corridor analysis, subsurface vegetation, data enrichment, mosaics and geographical information systems (GIS). The system is structured to allow hundreds of users to access it simultaneously.

THE DIPX DELIVERY SERVICE, A SUBSCRIPTION SERVICE AVAILABLE OVER THE INTERNET, TAKES THE WORK OUT OF THE EQUATION AND PROVIDES NORMALIZED GEO-SPATIAL DATA IN THE FORM OF DECISION PRODUCTS.

DATASTAR is also enhancing the system's mapping capabilities and colorizing data to give it depth. Furthermore, the data provided by DIPX is compatible with all of the GIS software packages on the market, including ArcView and ENVI, and ERDAS/Imagine.

The DIPX Delivery Service offers a certain amount of analytical capability by providing already-normalized geo-rectified data. Users of spatial imagery no longer have to search for the individual LANDSAT or other needed data, spend hours and hard drive space digesting it onto their systems plus additional time analyzing it to extract the needed information or downtime waiting for the requested data to be delivered. The images or maps that are created through DIPX are dynamically generated based on the layers and combinations of data chosen. Users simply click a button to add or subtract a layer of information, and create a completely usable information product or decision product.

By normalizing the data at the ingestion phase, DATASTAR ensures the content remains pristine and provides consistent results. Users can be sure that as long as the original data does not contain anomalies, the data extracted from DIPX is exact.

DIPX is essentially a unique system that accesses a geo-rectified spatial database. Most of the content is cadastral data, varying from local, regional and national levels. The goal is to be able to provide decision products on a global scale. Currently, if the data a customer is requesting is not publicly available, DATASTAR can have it collected for a fee. The user has the needed information, and DIPX becomes a more robust system.

The database is not bound by file size, only by the information available. "The information, or layers, is publicly available," said Jim Ramsay, project manager for DATASTAR. "It's the way it is housed and our ability to reach out and touch a portion of it that's proprietary."

What makes DIPX unique is how it incorporates ELAS into a format usable on most of today's popular systems, from PCs to larger UNIX and LINUX servers. The company also added interface ability to standard file structure and sequel database structure for control. The dimensionality of DIPX internals assures that the software is current with leading-edge hardware offerings in the computer industry. DIPX expands the original program's parameters and makes a previously difficult software program simple to use.

ELAS, at its best, was only able to read data from a spatial size of about 80 meters, which was state-of-the-art at the software's height of popularity in the 1980s. The original developers had the foresight to build the program modularly so certain capabilities could be added and expanded as the remote-sensing industry grew. Giant leaps in the quality of satellite data have demanded that processors also improve. DATASTAR has leveraged the original ELAS design to be able to address today's local and regional database requirements. DIPX also has the ability to read all of today's high-resolution imagery, including state-of-the-art, one-meter data.

Ramsay believes that because ELAS is not highly intuitive, placing it in a smaller, faster environment of DIPX will increase the variety of applications and the number of end-users. Obvious users of DIPX include farmers, city planners, real estate agents, site surveyors and archaeologists. But Ramsay said that basically anyone or any group with an interest in the spatial data of a given area can benefit from using DIPX.

Currently, one of the largest applications of DIPX data is in precision farming. By offering these services over the Internet, Ramsay sees DIPX as a tremendous resource for consultants that work with farmers to maintain the health and yield of crops and land. As a

subscriber to DIPX, such crop consultants can access DIPX with specific input parameters and create an information product about a tract of land. The consultant would then be able to make recommendations to the farmer, such as adding specific nutrients to the soil, irrigating, conducting pest control, etc.

"By providing this data, a crop consultation would be similar to a doctor who knows the needs of his patient," Ramsay said. "The crop consultant will have access to a variety of up-to-date information about that area of land, allowing him to produce a prescription for the crop."

Ramsay does not expect a system like DIPX to be a daily tool for every farmer and city planner in America—yet. "Since last March, we have leveraged this product with amazing success. And we're still improving and expanding," Ramsay said. "I think it will be an industrial strength tool for doing tremendous projects in 2002. Its evolution into a PC environment certainly opens up the possibilities."

"This is a textbook example of how NASA hopes businesses will use and expand upon those technologies designed for government use," said Kirk Sharp, manager of NASA's Office of Technology Transfer at Stennis. "Taxpayer dollars went into the original development of ELAS, and it only makes sense that the taxpayers are the ones to reap the benefits of the program. I think DIPX will continue the legacy of ELAS."

For more information on DIPX, contact DATASTAR, Inc. at 601/799-2439, *sales@datastar.net*. For more information on technology available from Stennis, contact Kirk Sharp, Stennis Space Center, 228/688-1929, *http://technology.ssc.nasa.gov*. Please mention you read about it in *Innovation*.

SOFTWARE UPGRADE SETS STAGE FOR ISS EXPANSION

The International Space Station (ISS) is ready for the assembly of its next major components—a football field-sized structural backbone supporting power, cooling and mobile robotics systems—now that a new generation of computer software is "booted up" and on the job.

The product of years of planning, months of testing and the transfer of about 2,500 files to and within the station, the new software is now in use aboard the orbiting laboratory following a carefully coordinated 12-hour process that was finished in February.

The software prepares the ISS for its new configuration with its main truss, which will support the station's solar arrays, radiators, mobile base system for the robotic arm and other equipment. The first element of the truss, the S0 (or S-zero), is to be launched aboard Atlantis on STS-110 in April. The successful software upgrade had to be completed before Atlantis could be launched.

One of the major new capabilities the new software provides allows activation of equipment on the S0 truss that will use Global Positioning System (GPS) data in the station's attitude control system. The new GPS capability will provide the primary guidance, navigation and control system of the station, transitioning Russian attitude-determination systems to a backup role.

"This software upgrade fits in well with what has been a very productive expedition," said Sally Davis, lead flight director for this stage of station operations. "We have demonstrated our ability to add major new capabilities to hardware and software, while we keep the International Space Station fully operational."

"The upload involved software for five American and Canadian computer systems, and affected their companion Russian systems," said Robert C. Dempsey, one of the International Space Station flight controllers at NASA's Johnson Space Center in Houston, who has been working for months to choreograph the new software installation and activation. Some 150 people in the United States, Russia and Canada participated in the software upload, from planning and testing to initialization. The procedures for the initialization of the computers with the new software were 106 pages long.

The technical name for the software package is the 8A Integrated Flight Load, named for the space station assembly-sequence flight for which it's required.

The initialization process was similar to restarting a personal computer network, including its servers and workstations, after a major operating system upgrade. However, it was vastly more complicated and had to be carefully coordinated among the computers onboard, including those in the station's Russian-built modules. Each of the system computers had to be loaded with the latest software and brought back online one-by-one so that at least two computers in each system were available to support day-to-day operations while the other was initializing its new software.

The work had to be done while Expedition Four commander Yury Onunfrienko and flight engineers Dan Bursch and Carl Walz were awake, because the station crew had to install new hard drives—sent up on a previous shuttle flight—into their laptop computers and follow along as the software was initialized. The software upload also was expected to trigger caution and warning alarms, which would have awakened a sleeping crew. In addition, some of the work had to be done over Russian ground stations, as computers in Mission Control Moscow introduced their computers to the new US software.

The process had to be completed expeditiously because of the possibility of glitches in computers with the new software trying to work while the others were still using the old software.

The next major software upgrade will not take place until April 2003 in preparation for STS-115. That mission will deliver the second truss segment for the port side of the station and the second set of large US solar arrays, doubling the power-generating capacity of the station.

For more information, contact Dwayne Brown at NASA Headquarters, 202/358-1726, *dbrown@mail.hq.nasa.gov*. Please mention you read about it in *Innovation*.

NASA Software to Help Speed Aircraft Departures

RESEARCHERS AIM TO AVERT AIRPORT gridlock with a new software tool being evaluated in NASA's virtual control tower simulator.

NASA researchers and Dallas/Fort Worth air traffic controllers conducted the second evaluation of the Surface Management System (SMS), being developed at NASA Ames Research Center located in California's Silicon Valley. Current systems used by airports don't provide controllers with accurate information about the number of future departures. During the various "rush hour" times at the airport, scheduled departures often exceed runway capacity, creating delays.

"The main objective of the Surface Management System is to allow the controllers and airlines to collaboratively manage departure operations and surface movements. The system gathers relevant information from multiple sources, processes it and displays the appropriate information and advisories to the users," said Dr. Steve Atkins, SMS project lead. "The system has the potential to decrease departure delays significantly," he added.

The information compiled by the system is displayed as aircraft location maps, departure timelines and load capacity graphs, giving controllers timely data to effectively manage aircraft movement between the terminal and the runway. With this information, controllers can predict possible traffic congestion and rapidly eliminate system bottlenecks.

Ames' FutureFlight Central (FFC) air traffic control tower simulator was used for the evaluation. FutureFlight Central gives controllers a unique facility to test software tools with its detailed 360-degree views, providing controllers a very realistic experience. The data collected will be used to refine the SMS user interface and identify additional user features.

THE INFORMATION COMPILED BY THE SYSTEM IS DISPLAYED AS AIRCRAFT LOCATION MAPS, DEPARTURE TIMELINES AND LOAD CAPACITY GRAPHS, GIVING CONTROLLERS TIMELY DATA TO EFFECTIVELY MANAGE AIRCRAFT MOVEMENT BETWEEN THE TERMINAL AND THE RUNWAY.

"We presented a spectrum of ideas in front of a group of FAA (Federal Aviation Administration) controllers and airline representatives to help us focus on what potential capabilities would be most helpful. Our ideas have been received positively," said Atkins.

The realism provided by FFC will allow for the smooth transition to the field test portion of the evaluation. Additional features, such as integration with arrival scheduling and other air traffic management tools, will be added as part of the staged evolution of the tool.

Other participants in the evaluation were representatives from the FAA's Free Flight Program Office, officials from major passenger and freight carriers, and controllers from Memphis, Tennessee, and Norfolk, Virginia airports.

The Surface Management System is being developed at NASA Ames Research Center by the Advanced Air Transportation Technologies (AATT) project, a part of the Aviation Systems Capacity Program. NASA Ames has been conducting air traffic control research and development since the mid-1980s.

For more information, contact Jonas Diño at Ames Research Center, 650/604-5612 or 650/604-9000, *jdino@mail.arc nasa.gov*. Please mention you read about it in *Innovation*.

X-38 Test Craft Completes Flight

THE X-38 PROTOTYPE CREW RESCUE VEHICLE successfully completed its highest, fastest and longest flight to date recently at NASA's Dryden Flight Research Center in Edwards, California—a test flight that intersected some of the most critical conditions such a craft would experience when returning from space.

"The X-38 tests involve innovative technologies that will be useful for many future human spacecraft, as well as a crew rescue vehicle," said X-38 Crew Return Vehicle (CRV) program manager John Muratore. "Although the production of the crew rescue vehicle for the station is deferred, we are continuing to test and mature these technologies to reduce the technical and cost risk of a future CRV production program."

The landing test, the eighth large-scale flight test for the program, began with the release of the X-38 from NASA's B-52 aircraft at an altitude of 45,000 feet, more than a mile higher than any previous test. During the test, the X-38 reached transonic speeds, velocities at the fringes of the sound barrier, as it flew free of the aircraft for almost a minute, descending three miles before its drogue parachute was deployed. The drogue parachute slowed the vehicle from more than 500 miles per hour to about 60 miles an hour, setting the stage for deployment of the 7,500-square-foot-parafoil wing. The X-38's parafoil is the largest one ever built, with a surface area more than one and a half times that of the wings of a 747 jumbo jet.

Descending under the parafoil, the X-38's proposed cockpit displays and controls were tested as an astronaut pilot remotely controlled portions of the craft's descent. The flight test also continued checkouts of European Space Agency-developed software that guides the parafoil, steering the X-38 to a safe landing. After a 12-minute gliding descent, the uncrewed X-38 touched down at a speed of less than 40 miles an hour on the clay surface of Rogers Dry Lake on Edwards Air Force Base, California.

The flight also successfully tested new X-38 flight control software modes specifically designed for a vehicle returning from space, improvements to the drogue parachute deployment and enhancements to the parafoil's landing accuracy. The test was the third X-38 mission using the parafoil sized for the actual space flight CRV. The test also was the third flight of an X-38 shape that includes a semicircular cross-section aft end. The European-influenced semicircular

The X-38 vehicle drops away from its launch pylon on the wing of NASA's NB-52B mothership as it begins its eighth free flight. Photo courtesy of Dryden Flight Research Center.

aft end could allow the X-38 to be compatible with launches on expendable vehicles.

The X-38 project combines proven technologies—a shape borrowed from a 1970s Air Force project—with some of the most cutting-edge aerospace technology available today. Although the United States has led the development of the X-38, international space agencies also are participating. Contributing countries include Germany, Belgium, Italy, The Netherlands, France, Spain, Sweden and Switzerland. NASA's Johnson Space Center, Houston, Texas leads the X-38 program and builds the test vehicles. NASA's Dryden Flight Research Center flight-tests the evolving X-38s.

For more information, contact Frank Cutler at Dryden Flight Research Center, 661/276-3998, *frank.cutler@dfrc.nasa.gov*. Please mention you read about it in *Innovation*.

KEEPING AIRCRAFT HEALTHY

Imagine a system onboard an aircraft that can tell when a system on the aircraft is developing the symptoms of a failure. The safety of that aircraft would be greatly increased, and the maintenance required would only be performed when necessary.

NASA Langley Research Center, in conjunction with ARINC, has developed such a system—the Aircraft Condition Analysis and Management System (ACAMS).

In July 2001, ARINC and a team from Langley performed a ground demonstration of this integrated onboard health management system. In this demonstration, intentional faults were injected into recorded flight data from the NASA Boeing 757 aircraft while running in real-time simulation and being processed through ACAMS. The ACAMS logic successfully identified the faults and provided an assessment of the impact on continued airworthiness of the aircraft prior to the conditions resulting in critical failure levels.

As NASA continues to work with ARINC, this team will refine ACAMS to meet diagnostic and prognostic objectives for landing gear and airframe-related systems, and prepare for more robust demonstrations to external NASA customers in FY 2002. A flight test of ACAMS is also planned for the FY 2003 timeframe. In addition to testing, NASA and ARINC hope to integrate ACAMS with ongoing propulsion system health management research and development activities.

For more information, contact John White at Langley Research Center, *j.j.white@larc.nasa.gov*. Please mention you read about it in *Innovation*.

Langley Research Center's B-757 test aircraft was used to perform a ground demonstration of an integrated onboard health management system. Photo courtesy of Langley Research Center.

Experiments Aid Airspace Safety

AN ALLIANCE OF TEAMS FROM NASA, THE US Navy, New Mexico State University in Las Cruces and industry recently demonstrated how remotely piloted aircraft can operate safely in the National Airspace System (NAS). Critical to gaining access to the skies is the requirement for remotely flown airplanes to be able to detect and avoid collision courses with other aircraft.

Using three detection systems, the teams—working as part of NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program—flew up to three aircraft, including a high-speed NASA F-18 jet, on simulated collision courses. Meanwhile, onboard technology automatically detected the threat and proposed a flight path to keep the aircraft out of danger. While all the aircraft in the tests had pilots onboard, the instrumented test airplane used equipment intended to permit future uninhabited aircraft to avoid other airplanes in flight. This new sensor technology may also benefit commercial airliner safety.

Central to the tests was the Proteus aircraft built by Scaled Composites in Mojave, California. Proteus carried see-and-avoid electronic devices that detected incoming airplanes.

Aircraft manufacturers are devising a variety of unpiloted aircraft capable of performing long-duration missions. Low-cost uninhabited aerial vehicles (UAVs) can be used to monitor wildfires, study environmental phenomena, relay cellular phone service and keep an eye on petroleum pipelines and remote borders. But before these UAVs can fly routinely in the national airspace along with traditional airplanes with pilots onboard, technologies must be validated to enable UAVs to mingle safely in the skies.

"The ERAST alliance has the opportunity to significantly increase the utility of remotely piloted aircraft by developing systems that enable UAVs to detect and avoid other aircraft," said NASA ERAST program manager Jeff Bauer of Dryden Flight Research Center, Edwards, California.

"The Federal Aviation Administration (FAA) must certify remotely piloted aircraft before they will be allowed to fly in the national airspace" Bauer explained. "Our allied efforts can help open the door to airspace use by UAVs. We can recommend certification and regulatory procedures to the FAA based on actual flight verification of remotely piloted aircraft safety systems."

The goals of the flights over southwestern New Mexico were to demonstrate see-and-avoid equipment capabilities and to show how a remotely piloted aircraft can be in constant communication with its ground pilot, even at distances over the horizon, by relaying signals via satellites.

The flight tests mobilized the resources of Dryden and ERAST partners, including the New Mexico State University Technical Analysis and Applications Center (TAAC) in Las Cruces, Scaled Composites, the Navy and Modern Technology Solutions, Inc. (MTSI) of Alexandria, Virginia. FAA observers also witnessed the operations at Las Cruces.

For the tests, Proteus was fitted with a Skywatch HP traffic advisory system, a radio-based device for detecting other aircraft. Additionally, Proteus carried two "non-cooperative" sensors—devices that don't require signals or transmissions from any other source—to detect the presence and course of other aircraft. These sensors are an Engineering 2000 infrared sensor and an Amphitech radar, both mounted in the nose of Proteus.

For more information, contact Fred Johnsen at Dryden Flight Research Center, 661/276-2998, *fred.johnsen@dfrc.nasa.gov*. Please mention you read about it in *Innovation*.

Scaled Composites' Doug Shane examines the screen of his ground control station during tests in New Mexico. Shane used this configuration as the ground control station to remotely pilot the Proteus aircraft during a NASA-sponsored series of test flights. Photo courtesy of Dryden Flight Research Center.

SBIR Technology Optimizes Aircraft Power Control

AURORA FLIGHT SCIENCES CORPORATION OF Manassas, Virginia has developed a Single-Lever Power Control (SLPC) that allows a pilot or autopilot to control the propulsion systems of general aviation or unmanned air vehicles (UAV) via a single lever or a single power command using a Full-Authority Digital Engine Control (FADEC) with optimal propeller/engine control.

Generally, the pilot controls the power plants of general aviation and lightweight aircraft through various levers. It is the pilot's responsibility to select speed settings for the propeller through a direct throttle setting on the engine in order to obtain a desired flight condition. Therefore, the selected operating conditions can be far from those ideal for best performance and are sometimes far from the conditions necessary for safe operation. The SLPC is a single-lever flight controller in the form of a single command from the pilot to the entire power plant system, which enables the power plant control unit to select optimum performance for any desired flight condition. The pilot is now free to concentrate on navigation and the control of the aerodynamic surfaces, if not under the control of the autopilot.

THE PILOT IS NOW FREE TO CONCENTRATE ON NAVIGATION AND THE CONTROL OF THE AERODYNAMIC SURFACES, IF NOT UNDER THE CONTROL OF THE AUTOPILOT.

Aurora developed and flight-tested the SLPC FADEC system in general aviation aircraft. These tests show fuel consumption improvement of more than 20 percent. The FADEC-controlled engines operated for more than 500 hours in test cells and in flight.

This technology was being used in NASA's Advanced General Aviation Transport Experiment

STTR SELECTED FOR FURTHER DEVELOPMENT

NASA has selected nine research proposals for negotiation of Phase II Contract Awards for its 2000 Small Business Technology Transfer (STTR) Program.

Phase II continues the development of the most promising previously selected Phase I projects. Selection criteria include scientific and technical merit, future importance and value of the innovation to NASA, company capabilities and commercial potential. Funding for Phase II contracts may be up to $500,000 for a two-year performance period.

Contractors completing Phase I projects submitted a total of 15 Phase II proposals. All proposals were peer-reviewed for both technical merit and commercial potential. The combined award total for the nine Phase II contracts is expected to be $4.5 million.

The goals of the STTR program are to stimulate technological innovation; increase the use of small business, including women-owned and disadvantaged firms, in meeting federal research and development needs; and increase commercialization of federally funded research results. Two of the nine companies are disadvantaged firms.

The program also requires small businesses to conduct cooperative research and development by partnering with a research institution.

The NASA STTR Program Management Office is located at the Goddard Space Flight Center, Greenbelt, Maryland, with executive oversight by NASA's Office of Aerospace Technology. Individual STTR projects are managed by NASA's field centers.

A listing of the selected companies can be found on the Internet at *http://sbir.nasa.gov*

For more information, contact Michael Braukus at NASA Headquarters, 202/358-1979, *mbraukus@hq.nasa.gov*. Please mention you read about it in *Innovation*.

The GENOA/Progressive Failure Analysis Software System can be used to simulate and predict aging and failure in all sorts of structural materials, including high-tech alloys and ceramics used in airplanes, cars, engines and bridges. Artwork courtesy of Glenn Research Center.

(AGATE) for integrated flight tests with all-digital cockpit technology components.

For more information, contact Tom Clancy at Aurora Flight Sciences, 703/369-3633, *tom_clancy@hiflight.com*. Please mention you read about it in *Innovation*.

Software Evaluates Structural Integrity

GENOA/PROGRESSIVE FAILURE ANALYSIS Software System, a failure-analysis software with unique predictive capabilities, tells designers not only how, where and why a part failed, but can assist the engineer in redesigning the part to make it defect free.

The software, developed by Alpha Star Corporation of Long Beach, California, via a 1995 Phase II SBIR award, in collaboration with Glenn Research Center of Cleveland, Ohio and Clarkson University of Potsdam, New York, is used for damage tolerance evaluation of elements made from all types of composites and metals, and impact-resistance evaluations of composite engine structures. Other accomplishments include durability evaluations of metal joints and prototype structures, and verified excellence in analysis of composite materials.

GENOA can be used to simulate and predict aging and failure in all sorts of structural materials, including high-tech alloys and ceramics used in airplanes, cars, engines and bridges.

The development of GENOA began at Glenn in the 1970s and was commercialized in 1998. The software can predict progressive aging and failure of materials as diverse as metals, ceramics, concrete and all types of composites. The ability to predict material and structural failure helps manufacturers build stronger aircraft fuselages, engines, car bodies and bridges. This is especially important today as commercial aircraft fleets age and many elements of road and bridge infrastructure near the end of their useful lives.

GENOA, a 1995 Phase II SBIR Award to Alpha Star Corporation, was a NASA Software of the Year Award winner in 1999. The software has also earned an R&D 100 Award winner in 2000, a Turning Goals into Reality Award in 2000 and the prestigious Tibbetts Award in 2001.

For more information, visit *http://www.alphastarcorp.com*. Please mention you read about it in *Innovation*.

SBIR PROJECTS SELECTED FOR PHASE II AWARDS

Nine research proposals have been selected for negotiation of Phase II contract awards for the 2000 SBIR Program.

Phase II continues development of the most promising previously selected Phase I projects. Selection criteria include scientific and technical merit, future importance and value of the innovation to NASA, company capabilities and commercial potential. Funding for Phase II contracts may be up to $600,000 for a two-year performance period. The combined award total for the nine Phase II contracts is expected to be $5.4 million.

The goals of the NASA SBIR Program are to stimulate technological innovation; increase the use of small businesses, including women-owned and disadvantaged firms, in meeting federal research and development needs; and increase the commercialization of federally funded research results.

A total of 259 proposals were submitted by SBIR contractors completing Phase I projects. The evaluation of these proposals resulted in nine awards. Due to the availability of funding, these awards were made in addition to 126 proposals that were previously selected on November 20, 2001. A listing of the selected companies can be found on the Internet at *http://sbir.nasa.gov*.

For more information, contact Bob Nelson, Deputy SBIR/STTR Program Manager, 301/286-0077, *Robert.W.Nelson@gsfc.nasa.gov*. Please mention you read about it in *Innovation*.

TECHNOLOGY OPPORTUNITY SHOWCASE

Moving Forward

Technology Opportunity Showcase *highlights some unique technologies that NASA has developed and that we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in* Innovation.

Accelerating Electronic Thermometer Readings

NASA Stennis Space Center is seeking qualified companies to license this advanced adaptive predictive algorithm for use in commercial applications. The algorithm reduces the time required to determine final steady-state temperature. This technology accelerates temperature determination time by using sample readings and computing the final temperature with the predictive algorithm. It is quick, accurate and robust, and can be used in a variety of commercial electronic thermometer applications.

Benefits of the technology include: faster response time—can improve the response time of existing sensors without additional sensor development or creating a new sensor; accuracy—does not sacrifice accuracy for speed; robustness—can be used with various types of temperature sensors and potentially other types of sensors; and simple integration—can be implemented with erasable, programmable read-only memory (EPROM) in existing systems.

Potential commercial applications include uses for industrial control with nuclear power, chemical processing and industrial processing; medical applications in medical clinics, for home use and in veterinary clinics; and for hydrogen or gas-detection systems.

The adaptive predictive algorithm for electronic thermometers uses sample readings during the initial rise in temperature and applies an algorithm that accurately and rapidly predicts the steady-state temperature. The final steady-state temperature of an object can be calculated based on the analysis of the temperature signals acquired by the sensor and predetermined variables from the sensor characteristics. This advanced algorithm can be implemented in existing software or hardware with an EPROM. The capability for easy integration eliminates the expense of developing a whole new system that offers the benefits provided by this technology.

For more information, contact the National Technology Transfer Center, Marketing Department, 316 Washington Ave., Wheeling, WV 26003, 800/678-6882, *hottechnologies@nttc.edu.* Please mention you read about it in *Innovation*.

Perilog Contextual Search and Retrieval Software Tools

NASA Ames Research Center seeks companies to commercialize Perilog, a suite of data-mining tools that retrieves and organizes contextually relevant data from any sequence of terms (text, musical notes, genetic data, etc.). It is an integrated set of methods that can be used to intelligently mine information from databases.

Perilog unearths data that is contextually relevant to the subject being investigated. The software measures the degree of contextual association for large numbers of term pairs in text to produce models that capture the structure of the text. Perilog statistically compares these models to measure their degree of similarity to a query model, develops a ranking and presents the search results to the user. Perilog was originally designed to support the FAA's Aviation Safety Reporting System (ASRS). The ASRS testbed demonstrated Perilog's power on a topical database of thousands of documents. The algorithm was powerful enough to produce the first quantitative evidence of situational relationships between reported commercial aviation incidents and a specific type of aviation accident.

Perilog relies on four methods for mining contextually relevant data: keyword-in-context search—retrieves narratives that contain one or more user-specified keywords in typical or selected contexts, and ranks the narratives on their relevance to the keywords in context; flexible, model-based phrase search—retrieves narratives that contain one or more user-specified phrases, and ranks the narratives on their relevance to the phrases; model-based phrase generation—produces a list of phrases from documents that contain a user-specified word or phrase; and narrative-based phrase discovery—finds phrases that are related to topics of interest by generating a list of narratives similar in meaning to the keyword or phrase query.

Perilog offers the following features: analysis by measuring contextual associations within sequences; relevance ranking by ranking collections of contexts on similarity to other collections of contexts; search by providing more effective key term and phrase search; phrase mining by helping users to know what phrases occur in a database and discovering phrases that are contextually related to key terms or phrases; and modeling by representing contexts within sequences as pairwise inter-term contextual associations having quantified degrees of association.

Perilog has applications in a multitude of fields and is available for licensing now. For additional technical descriptions, please see the following Web sites: *http://ettc.usc.edu/ames/perilog/homepage.html* and *http://human-factors.arc.nasa.gov/IHpublications/mcgreevy/*

For further information, contact the National Technology Transfer Center, Marketing Department, 316 Washington Ave., Wheeling, WV 26003, 800/678-6882.

NASA ONLINE

Go to the **NASA Commercial Technology Network (NCTN)** at ***http://www.nctn.hq.nasa.gov*** to search NASA technology resources, find commercialization opportunities and learn about NASA's national network of programs, organizations and services dedicated to technology transfer and commercialization.

NASA Field Centers

Ames Research Center
Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

Carolina Blake
Ames Research Center
Moffett Field, California 94035-1000
650/604-1754
cblake@mail.arc.nasa.gov

Dryden Flight Research Center
Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

Jenny Baer-Riedhart
Dryden Flight Research Center
Edwards, California 93523-0273
661/276-3689
jenny.baer-riedhart@mail.dfrc.nasa.gov

Glenn Research Center
Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High-Temperature Materials Research, Microgravity Science and Technology, and Instrumentation Control Systems.

Larry Viterna
Glenn Research Center
Cleveland, Ohio 44135
216/433-3484
Larry.A.Viterna@grc.nasa.gov

Goddard Space Flight Center
Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

George Alcorn
Goddard Space Flight Center
Greenbelt, Maryland 20771
301/286-5810
george.e.alcorn.1@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics and Autonomous Systems.

Merle McKenzie
Jet Propulsion Laboratory
Pasadena, California 91109
818/354-2577
merle.mckenzie@jpl.nasa.gov

Johnson Space Center
Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations.

Charlene Gilbert
Johnson Space Center
Houston, Texas 77058
281/483-0474
charlene.e.gilbert@jsc.nasa.gov

Kennedy Space Center
Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

Jim Aliberti
Kennedy Space Center
Kennedy Space Center,
Florida 32899
321/867-6224
jim.aliberti-1@kmail.ksc.nasa.gov

Langley Research Center
Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

Dr. Wilson T. Lundy
Langley Research Center
Hampton, Virginia 23681-2199
757/864-6005
w.t.lundy@larc.nasa.gov

Marshall Space Flight Center
Selected technological strengths are Materials, Manufacturing, Non-Destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

Vernotto McMillan
Marshall Space Flight Center
Huntsville, Alabama 35812
256/544-2615
vernotto.mcmillan@msfc.nasa.gov

Stennis Space Center
Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Non-Intrusive Instrumentation.

Kirk Sharp
Stennis Space Center
Stennis Space Center, Mississippi
39529-6000
228/688-1914
kirk.sharp@ssc.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint-sponsored research agreements and incubate small start-up companies with significant business promise.

Bill Musgrave
Ames Technology Commercialization Center
San Jose, CA
408/557-6820

Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS
228/688-3144

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
440/260-3300

David Kershaw
Florida/NASA Business Incubation Center
Titusville, FL
321/267-5601

Bridget Smalley
University of Houston/NASA Technology Center
Houston, TX
713/743-9155

Joanne Randolph
Business Technology Development Center
Huntsville, AL
256/704-6000, ext. 202

Julie A. Holland
NASA Commercialization Center/California State Polytechnic University
Pomona, CA
909/869-4477

Martin Kaszubowski
Hampton Roads Technology Incubator
Hampton, VA
757/865-2140

Ann Lansinger
Emerging Technology Center NASA Business Incubator
Baltimore, MD
410/327-9150

Small Business Programs

Carl Ray
NASA Headquarters
Small Business Innovation Research Program (SBIR/STTR)
202/358-4652
cray@hq.nasa.gov

Paul Mexcur
Goddard Space Flight Center
Small Business Technology Transfer (SBIR/STTR)
301/286-8888
paul.mexcur@pop700.gsfc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D agencies and to foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

Ken Dozier
Far West Technology Transfer Center
University of Southern California
Los Angeles, CA 90007
213/743-2353

William Gasko
Center for Technology Commercialization
Westborough, MA 01581
508/870-0042

David Bridges
Economic Development Institute
Georgia Institute of Technology
Atlanta, GA 30332
404/894-6786

Gary F. Sera
Mid-Continent Technology Transfer Center
Texas A&M University
College Station, TX 77840
979/845-8762

Charlie Blankenship
Technology Commercialization Center, Inc.
Newport News, VA 23606
757/269-0025

Pierrette Woodford
Great Lakes Industrial Technology Center
Battelle Memorial Institute
Cleveland, OH 44135
216/898-6400

Joseph P. Allen
National Technology Transfer Center
Wheeling Jesuit University
Wheeling, WV 26003
800/678-6882

Dan Winfield
Research Triangle Institute Technology Applications Team
Research Triangle Park, NC 27709
919/541-6431

Events

The ***Annual Meeting of the Federal Laboratory Consortium for Technology Transfer*** will be held May 6–10, 2002 in Little Rock, AR. Go to *http://www.federallabs.org/* for meeting information.

Awards

NASA Software Earns Technology Transfer Award

The VISAR (Video Image Stabilization and Registration) software technology developed at NASA's Marshall Space Flight Center (MSFC) has been selected to receive the 2002 Excellence in Technology Transfer award from the Federal Laboratory Consortium. This competitive honor adds to the extensive praise VISAR received for its unparalleled performance during the FBI investigation of the 1996 Olympics bombing in Atlanta. The Windows-based VISAR software program utilizes a unique, patent-pending process to dramatically improve videotape sequences and still images extracted from moving video. Recognizing the broad potential of the technology, including law enforcement, security, industrial and consumer applications, MSFC has licensed VISAR for use in electronics and is currently offering the technology for licensing to software producers. Government agencies may also obtain the software for their use.

For more information, go to the MSFC Technology Transfer Program Web site (*http://techtran.msfc.nasa.gov/*) or contact Sammy Nabors at ✉ *sammy.nabors@msfc.nasa.gov*. Please mention you read about VISAR in *Innovation*.

Heads-Up

Visit the newly redesigned Headquarters Web site for the online ***NASA Commercial Technology Network*** at *http://www.nctn.hq.nasa.gov* to access NASA technology opportunities, commercialization resources and much more!

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